Smart Crop Suitability System

Project ID: 19-015

Requirement Design Document

Author:
P.L.N. Lakshitha – IT16021594

B.Sc. Special (Honors) Degree in Information Technology
Department of Information Technology

Sri Lanka Institute of Information Technology Sri Lanka

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Supervisor:
Dr.Anuradha Jayakody

B.Sc. Special (Honors) Degree in Information Technology
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DECLARATION

We declare that this is our own work and this Design Document Specification does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of our knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Author:

P.L.N.Lakshitha
IT16021594

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1 INTRODUCTION

1.1 Purpose

The predominant purpose of this Requirements Design Document (RDD) is to provide a detailed description of the functionalities of the system 'Smart Crop Suitability System'. Therefore, this document will cover each of the system's intended features, as well as offer a preliminary glimpse of constraints and their effects on the system. The document will also cover hardware, software, and various other technical dependencies. [1]

The main motive of this document is to acknowledge the implementation of sensor subsystem of the system. As one of the main parts of the system, a detailed description is presented about the components which assist used in the system. Special features to be added and conclusion made at the end of the literature survey which led to the necessity of the features are discussed. Furthermore, the required duration of the implementation within the time frame and the deliverables to be distributed at the end of the implementation are reported in detail.

1.2 Scope

This document will cover how the proposed system's main objective Develop the sensor sub system using pH and Humidity sensors and establish the entire system for the data communication with the Raspberry Pi. Using the sensor subsystem sensor readings (pH, EC, moisture, temperature) from soil use to develop the algorithm using machine learning.
Algorithm can generate soil nutrients from sensor readings and suggest the most suitable crop considering the main soil nutrients. Such as N, P, K, and environmental factors with ground type (rough, salty, sand) can predict the most relevant crop for the soil. Establish the entire system to data communication with cloud to remote access to all sensor data (pH, EC, moisture, temperature) in soil. check entire system for the errors for the final product.[2]

1.3 Definitions, Acronyms, and Abbreviations

UI	User Interface
Raspberry	raspberry is an open-source electronics platform based on easyto-use hardware and software
pH	pH is a measure of hydrogen ion concentration, a measure of the acidity or alkalinity of a solution. The pH scale usually ranges from 0 to 14.
Humidity	Humidity is the amount of water vapor in the atmosphere. Water vapor is the invisible presence of water in its gaseous state. Humidity is a significant aspect of the atmosphere because it affects the weather and the climate.

Table 1

1.4 Overview

The main expect of this design document is to provide a full description of the proposed research topic. All the non-functional and functional requirements are clearly discussed in detail in this document.
A full description of the proposed product and the system according to the functions is given in the first section of this design document.

As well, an overall description of each system function is provided in the second part of this. All the hardware interfaces, system interfaces, memory constraints and all the operations are described here. On the other hand, for more effectiveness of the reader, the full system will be discussed with the use case and sequence diagram.

In the third section of the document, all user requirements, hardware and software requirements, architectural diagram, budget, and the risk mitigation plan details are described clearly. This will be more helpful to the developers as all the essential details are provided it will be much easier to deal with developing process.

All the supporting information and the references are mentioned at the final part of the document. Throughout the document, all the details of the proposed product are described in detailed.

2 OVERALL DESCRIPTION

The whole overview of the proposed product is described broadly throughout this section. Discuss the main goals and the way of achieving those and the way of affecting this to the user is clearly discussed by this section.

Several important processes are discussed in this section such as how the operations are going to be executed and control, how these operations communicate with users, system requirements, relevant interfaces and how each component activities are going to communicated with other components and the importance for the successful final product.

As well, all the definitions are provided at the top of the document and it will be more helpful to get a clear idea of the whole process and the future changes of the system. As the design document provides hardware component details, it will be more effective with developers as well.

2.1 Product Perspective

With the improvement of innovation and IT industry, a few people have concentrated on "smart crop suitability " idea [1][2]. Be that as it may, in Sri Lanka, there is elusive data about this sort of inquiries about. In spite of the fact that there are a few items are accessible, this proposed item has such a large number of curiosity highlights like remind the client to plant crops, give the everyday use, get the real use of ground at once, track areas and recommend areas which have different kind of soil, break down the personas and so on. If we simply discussed all four components,

In most of those products, a simple notification process has used to Crop stage level fertilizer prediction for a particular ground. But in our proposed product, two separate algorithms for these two processes. The Predicting the best crop for particular ground will be controlled according to the pH, EC, humidity and temperature. As well, the separate algorithm will be executed to Crop stage level fertilizer prediction for the plant to get the best result by the recommend fertilizer levels. [3]

2.1.1 System Interfaces

“Smart crop suitability “mobile application runs on both Android and iOS platform. Because Xamarin will be used for developing the application. The application will get some details from internet. As well, Raspberry platform is going to be used to develop the hardware comports.

2.1.2 User Interfaces

There are several interfaces have proposed in this smart one mobile application to make it more user-friendly. They are,

1. Insert data

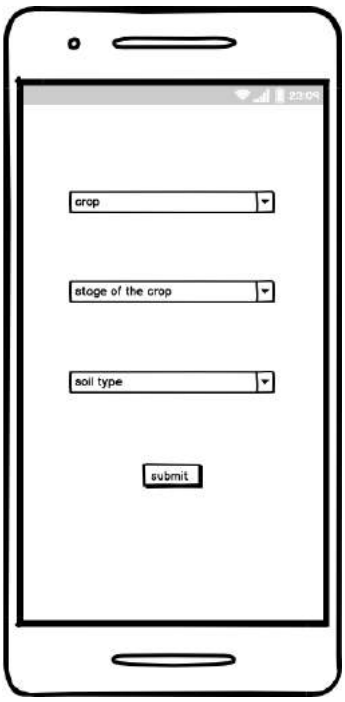

Figure 1

2 view recommended fertilizer levels

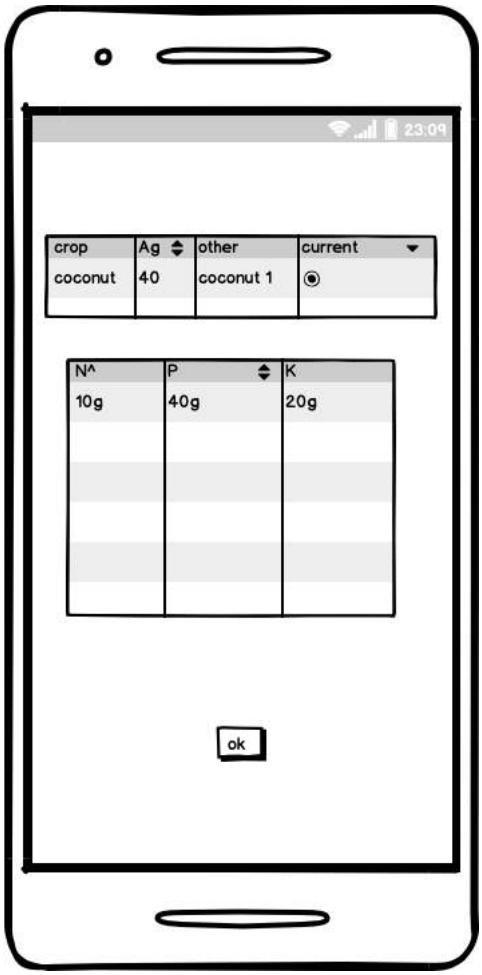

Figure 2

2.1.3 Hardware Interfaces

As there are several main and sub-objectives in this proposed product, some hardware components are going to be used to satisfy those. According to the particular function,

- pH sensor
- Humidity sensors

2.1.4 Software Interfaces

Xamarin	Developing Android and IOS Mobile Application
raspberry desktop application	Hardware configuration purposes
Firebase	NoSQL database management

Table 2

2.1.5 Communication Interfaces

"Smart crop suitability system", smart sensor device and mobile phone will be connected using WIFI technology. And smartphone should be connected to the internet using mobile data or WIFI. As well, GPS module will be used by the smart sensor device for getting the soil ground locations. Communication between the mobile app and Firebase required internet. [4]

2.1.6 Memory constraints

The Android or IOS mobile application is required,

- Android version should be 5.0 or higher
- IOS version 10.0 or higher
- 1 GB Ram
- 100 MB Memory space

2.1.7 Operations

Although the final outcome is a product, the mobile application will be interacted with the process for achieving particular goals. Therefore, to use this proposed product, the user should install the "smart crop suitability" mobile application.

1. The user should sign in and if he doesn't have an account, then he should create an account.
2. When the mobile application is going to be installed for the first time, the ground details (location and soil type) should be provided at the same time.
3. Other required details should be completed according to relevant function.
4. To get the location details, mobile location services should be enabled.
5. For the internet facility, mobile data or wifi should be enabled.

2.1.8 Site adaptation requirements

English will be used for the notifications and the application interfaces. For the communication and other features, mobile WIFI facility, location services, and mobile data should be enabled. As well, for the efficiency of the proposed product a database is going to be managed and through that, each and every user's details can be stored with the relevant ground identification. Firebase will be used as the database for achieving this.

2.2 Product functions

In the "smart crop suitability" product based mobile application has several functions, according to my function which,

• Crop stage level fertilizer prediction
To achieve this, an algorithm will be generated by using several parameters like stage of the plant, ground soil type, fertilizer level

Input	stage of the plant, ground soil type, fertilizer level
Output	Recommended fertilizer levels according to plant stage
Process	Input data will be analyzed by an algorithm and suggest the best fertilizer plan for the relevant stage of plant

Table 3

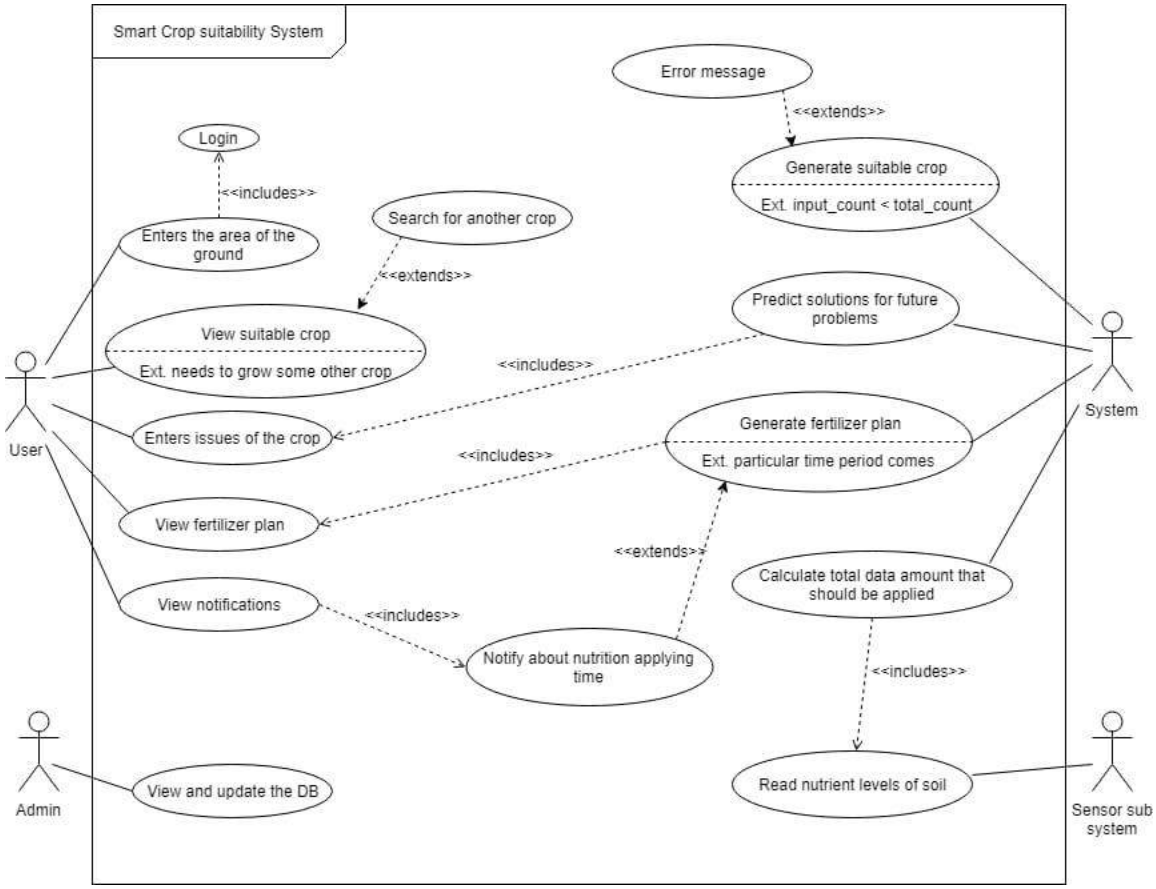
Smart Crop suitability System
Error message
<<extends>>
Generate suitable crop
Ext. input_count < total_count
Login
<<includes>>
Enters the area of the ground
Search for another crop
<<extends>>
Predict solutions for future problems
View suitable crop
Ext. needs to grow some other crop
<<includes>>
System
User
Enters issues of the crop
Generate fertilizer plan
Ext. particular time period comes
<<includes>>
View fertilizer plan
<<extends>>
Calculate total data amount that should be applied
View notifications
<<includes>>
Notify about nutrition applying time
<<includes>>
Admin
View and update the DB
Read nutrient levels of soil
Sensor sub system

Figure 3

Use case ID	01
Use case Name	Generate Fertilizer Plan
Goal in Context	To Generate Fertilizer Plan based on current fertilizer level on the ground
Primary Actor	system
Preconditions	1. There is an internet connection to the mobile phone. 2. There is a database connection to the user. 3. System connected to smart crop suitable device through WIFI connection
Main Success Scenarios	1. Include (View suitable crop fertilizer plan). 2. Replace the new crop fertilizer plan.
Extensions	Particular time come

Table 4

2.3User characteristics

The “smart crop suitability system” product mainly depends on the mobile application and a tool with sensor hardware components. Because of that, the user must have the minimum knowledge to use a smartphone, use the sensor tool, basic knowledge of cultivation and fertilizers and English language skills. Because of this Product is based on cultivation, mainly target the farmers who have main idea about using smart devices.

2.4 Constraints

- A smartphone is required with enough battery life.
- For the communication between smart crop suitable system tool and the smartphone, required wifi connectivity enabled in a smartphone.
- For the communication between the smartphone and the database, required internet connectivity enabled in the smartphone.
- Android used, for the mobile application development,
- Cloud data base is used to store data to retrieve in relevant points.
- With the limited phone memory, the application should be able to run without any effect on the other operations and the processing speed.
- Raspberry pi3 model b+ board is required to use and some data is going to be stored in there.

2.5 Assumptions and dependencies

- The smart phone is switch on throughout the day as well as have the enough power of battery.
- The WIFI connectivity and the internet connectivity always enabled in the smart phone.
- Mostly the smart crop suitability system is used by people who have basic knowledge about fertilizers and cultivation.
- The information (ground details & details about fertilizer levels) which is provided by the user is correct
- Soil samples taken by zig zag method.
- Soil samples will get an average fertilizer level of whole ground.

2.6 Apportioning of requirements

For used this “smart crop suitability system”, first user must download “smart crop suitability system” mobile application from the google play store. After the install the application. after download the application user can provide details of user for the registration process and after registering process complete up user can log to the system using relevant credentials.

After the login and configuration, user mainly direct to the home page. In here user can visible some tips of cultivating. Additionally, user can select main functions of the system (Recommend the best crop, Recommend the fertilizer usage, Suggest the future fertilizer plan).

User have to enter relevant data to particular functions such as stage level of crop, select the user defined crop.

3 SPECIFIC REQUIREMENTS

3.1 External interface requirements

3.1.1 User interfaces

1. Sign up – As the first step, user has to sign up with the mobile application.
2. Create an account – If the user doesn't have an account, then this interface will give facility to create an account within simple steps.
3. Login- using user credentials user can log in to the system.
4. Home page-Through this interface user can view cultivating tips and redirect to the other main functions using buttons.
5. Recommend the best crop interface-Through this interface user can view the best crop recommendation for the ground fertilizer level by analyzing the data set which get by the tool.
6. Recommend the fertilizer usage interface-Through this interface user can view the recommended fertilizer by providing the selected crop
7. Suggest the future fertilizer plan interface-Through this interface user can view future plans and fertilizer levels according to the plant stage.
8. Fertilizer level indicating alert-in this interface app showing the current fertilizer level of the soil by retrieve data set from the tool.
9. User Details view interface-In this interface user can view details of the user account.

3.1.2 Hardware interfaces

As there are several objectives to achieve the final product feature, some hardware components are going to be used to satisfy those. Those hardware components are,

- Ph sensor -to identify ph level of the soil
- Temperature sensor -to identify the temperature of the soil
- Humidity sensor -to identify the water level of soil
- Electricity conductivity sensor-to measure ability to conduct electricity
- WIFI module- -for communication purpose between the mobile, smart crop suitability tool
- Smart phone - for the mobile application, suggest crops, show locations and user will be notified through the mobile. (Android version 6.0 or higher)
- Raspberry bi 3 model b+ –as the sensor hub

  With all these hardware components and parameters, this proposed product will able to be more effective and accurate.

3.1.3 Software interfaces

Some software interfaces have to be used in this proposed system and they can be simply categorized with the relevant function and it will be able to understand clearly. Those are,

Test soil sample and show the details of the soil by fertilizer wise: raspberry desktop application will be used to configure sensors.

Android Studio will be used to implement the mobile app.

Google map API will be used for notifying the user about the soil state of the land according to the locations.

Identify the user: To configure the database with the mobile application, developer need the "Firebase" web application.

3.1.4 Communication interfaces

Mainly in this component the communication process will be happened through the WIFI connectivity. Therefore, raspberry pi and phone is connected always to retrieve data. As well for the communication between the application and database, and for crowdsourcing, internet facility should be enabled.

Moreover, the smart crop suitable system will get the current location using GPS module.

3.2 Architectural Design

3.2.1 High-level Architectural Design

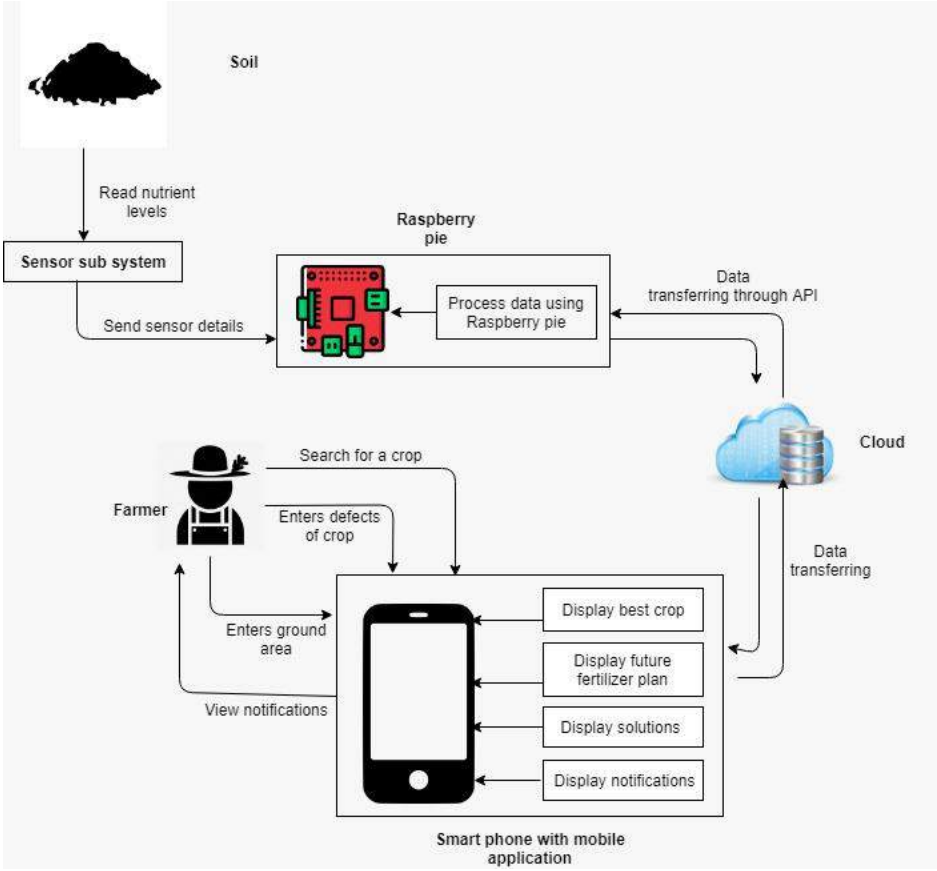

Figure 4

3.2.2 Hardware and Software requirements with justification

As our proposed product will address to a common issue for human life the final outcome should be more effective and accurate. Therefore, several software and hardware components have to be used for achieving this.
To satisfy each and every requirement, several hardware components will be used such as,

PH sensor and humidity sensor will be used for checking the quality of water. PH sensor checks the water's pH value and it should be between 6.5 and 7.5. humidity sensor will be used for checking the vapor of soil.

GPS module uses for getting the current location it will send to the mobile phone using WIFI technology.

For the communication process among smart phone and smart device, a WIFI module is required to use.

As well, for the developing process, a raspberry board will be used at the bottom of the smart device.

With all these hardware components the proposed product will be an effective product for the human life.

3.2.3 Risk Mitigation Plan with alternative solution identification

Risk	Impact	Likelihood (%)	Mitigation Plan
pH Sensor is giving a faulty reading	3	5%	sensor is going to be used for quality checking
Humidity Sensor is giving a faulty reading	3	5%	sensor is going to be used for quality checking
temperature Sensor is giving a faulty reading	3	5%	sensor is going to be used for quality checking
EC Sensor is giving a faulty reading	3	5%	sensor is going to be used for quality checking
If there no network coverage in this place	1	50%	Save the data mobile phone and after available network saved in the database
Machine learning algorithm result is less accurate	3	30%	Train the algorithm using more data sets

Table 5

3.2.4 Cost-Benefit Analysis for the proposed solution

Description	**Quantity**	**Price(Rs)**
Ph Sensor	1	350.00
Humidity sensor	1	350.00
Temperature Sensor	1	200.00
EC meter	1	450.00
HDMI to VGA adaptor	1	1225.00
Raspberry Pie 3 kit	1	7450.00
Screen for raspberry pi	1	1400.00
Memory card 16GB	1	1500.00
	Total	**12925.0**

Table 6

3.3 Performance requirement

It is expected that the proposed system will perform all the requirements stated under the functional requirements section. Some performance requirements identified are listed below:

- The performance of the smart crop suitability system will depend on the battery life.
- The sensor readings must be correct and trustworthy in the smart device of crop suitability system.
- The mobile application performance is going to depend on mobile phone's

  battery life, RAM, WIFI, and internet connectivity

- PH sensor, humidity sensor, temperature sensor, EC meter sensor can transfer data within less than one second.

3.4 Design constraints

This product is focused on people age limitation of 15 or above, the user interfaces of the "Smart crop suitability" mobile application have to be simple, attractive as well as user-friendly. Therefore, people will be able to work with the proposed product easily and effectively with the use of these designed user interfaces. Also, the smart device of sensors needs to be simple and attractive.

3.5 Software system attributes

3.5.1 Reliability

As this product address a common issue of people who has an interest in cultivation, the reliability of the proposed product is important. According to this research component,

• The sensor readings must be 100% accurate because most important actions will be based on them.

• To data communication between cloud, internet connectivity should be enabled.

• The system will be tested using several techniques to make sure it's probability of failure is very low value.

• If there will be a failure in the system a proper mechanism is going to be implemented to show the failures.

• At a time of failure, there should be a way to overcome through that immediately.

3.5.2 Availability

- Always servers need to be available because this system functions working with server data.
- This application should be a real-time application. It is working with real-time data.
- When a user needs mobile phone reset or changes the mobile. We are going to implement the backup option to recover user details.
- The sensor sub system and the mobile application should be easily understandable to users and it should be real time

3.5.3 Security

For user sign up for the mobile application, unique email address or phone number needs to be used by the user. The login details of the user will be sent to the database in the encrypted version. Therefore, user details and other personal details will be secured.

3.5.4 Maintainability

The sensor sub system will be used to get the data through sensors. Other algorithms and functions to process the accurate results will be handled by using the Raspberry pie board and the cloud server. Therefore, if any change occurs in the system, it will be easier to maintain that situation by using an application update or changing the server data.

4. REFERENCES

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